CLAIMS:-

1. A composition of matter comprising
(a) a metal powder,
(b) a solder powder which melts at a lower temperature than the metal powder,
(c) a polymer, or a monomer which is polymerisable to yield a polymer, a said polymer being crosslinkable under the action of a chemical cross-linking agent,
(d) a crosslinking agent for said polymer, the crosslinking agent having fluxing properties and being nonreactive with said polymer without the application of heat and provision of a catalyst for reaction therebetween, the crosslinking agent, as such not reacting with said polymer under storage conditions, and the crosslinking agent being capable of solvating
(e) metallic oxide and metallic salt catalysts which are formed by heating metallic components (a) and (b) and which promote a rapid crosslinking reaction between said polymer (c) and said crosslinking agent (d) when incorporated in said polymer, as a result of solvation by the crosslinking agent in the presence of heat.

2. A composition according to Claim 1, wherein said metal powder is selected from Au, Ag, Cu, Zn, Al, Pd, Pt, Rh, Fe, Ni, Co, Mo, W, Be, and alloys thereof.

3. A composition according to Claim 2 wherein said metal powder is copper.

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4. A composition according to Claim 1~~, 2 or 3,~~ wherein said solder powder is selected from Sn, Bi, Pb, Cd, Zn, Ga, In, Te, Hg, Sb, Se, Tl and alloys thereof.

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5. A composition according to Claim 4 wherein said solder powder alloy is Sn63Pb37.

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6. A composition according to ~~any preceding~~ claim 1 wherein said cross-linking agent is selected from carboxylated polymers, dimer fatty acids, and trimer fatty acids.

7. A composition according to Claim 6 wherein said cross-linking agent is a styrene-acrylic acid copolymer, and/or an organic trimer acid having a functionality greater than 1.

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8. A composition according to ~~any preceding~~ claim 1 wherein said catalyst is formed by heating and oxidation of solder powder and dissolved by the fluxing agent.

9. A composition according to Claim 8 wherein said catalyst is a metallic oxide catalyst formed by heating and oxidation of tin and/or lead powder and dissolved by the fluxing agent.

10. A composition according to Claim 1 wherein said catalyst is a metallic salt catalyst formed by heating and oxidation of metal powder or solder powder to form a metallic oxide and reaction of the metallic oxide with resin or solvent to produce organo-metal salts.

11. A composition according to Claim 10 wherein said catalyst is a tin salt catalyst formed by heating tin to form a tin oxide and reaction of the latter with resin or solvent to produce tin salt.

12. A composition according to Claim 10 wherein said catalyst is a copper salt catalyst formed by heating copper to form a copper oxide and reaction of the

latter with resin or solvent to produce a copper salt.

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13. A composition according to any preceding claim, wherein an organic chelating agent is adhered to the metal powder as stability enhancer and the organic chelating agent decomposes at solder melting temperature to provide decomposition products which dissolve in the fluxing agent as additional catalyst for the chemical crosslinking agent.

14. A composition according to Claim 13 wherein said organic chelating agent is an azole chelating agent.

15. A composition according to claim 13 wherein said organic chelating agent is benzotriazole.

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16. A composition according to any preceding claim further comprising a copper salt deactivator as a stability enhancer.

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17. A composition according to Claim ~~18~~ 16 wherein said copper salt deactivator is oxalyl bis benzylidene hydrazine.

18. A composition on, or for application to, a dielectric substrate in a predetermined pattern comprising, in admixture:

(i) a metallic powder component which includes (a) a solder powder and (b) a metal powder melting at a higher temperature than the solder powder; and

(ii) a polycarboxyl compound effective as a fluxing agent for the metallic powder component at a first temperature and as a cross-linking agent for an epoxy resin at a higher second temperature, the polycarboxyl compound being in contact with such epoxy resin.

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19. A composition according to claim 18 which has the epoxy resin in admixture with the metallic powder constituent and the polycarboxyl compound.

20. A composition according to claim 18, which has the epoxy resin pre-applied to the dielectric substrate.

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37 ~~21~~. A composition according to claim 19 ~~20~~, wherein the epoxy resin is printed on the substrate in a predetermined pattern.

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aa

19 ~~22~~. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to 21~~, wherein the polycarboxyl compound is thermally stable to 215°C and has an acid number greater than 200 and a viscosity less than 0.01 Pa.s (10 centipoise) at 200°C.

~~23. A composition according to any one of claims 18-22, wherein the polycarboxyl compound is selected from: carboxylated polymers, polycarboxylic acids and polymer fatty acids.~~

aa

20 ~~24~~. A composition according to claim 18 ~~23~~, wherein the polymer fatty acid is a dimer or trimer fatty acid.

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21 ~~25~~. A composition according to claim 18 ~~23~~, wherein the carboxylated polymer is a styrene-acrylic acid copolymer.

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aa

22 ~~26~~. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to 25~~, wherein the metal powder component contains up to 90% by weight of metal powder (b) and from <100 to 10% by weight of the solder powder.

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aa

23 ~~27~~. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to 26~~, wherein metal powder (b) is a metal selected from Au, Ag, Cu, Zn, Al, Pd, Pt, Rh, Fe, Ni, Co, Mo, W, Be,

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and alloys thereof.

aa ~~28~~ 24. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to~~ aa ~~27~~, wherein the solder powder is selected from Sn, Bi, Pb, Cd, Zn, Ga, In, Te, Hg, Sb, Se, Tl and alloys thereof.

aa ~~29~~ 25. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to~~ aa ~~28~~, wherein the solder powder includes a first metal and a second metal, with the first metal having an affinity for the high melting point constituent, an oxide of the second metal being a catalyst for the curing of the epoxy resin and the first and second metals being melted together to form a metal film in which is embedded particles of the high melting point constituent while the first and second molten metals form a matrix in regions between the particles of the high melting point constituent, which matrix is rich in the second metal of the relatively low melting point constituent.

30. A composition according to claim 29, wherein the solder powder is a tin/lead alloy.

Sub B4 aa 31. A composition according to claim 29 ~~or 30~~, wherein metal powder (b) is copper.

aa ~~32~~ 28. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to~~ aa ~~31~~, wherein the metallic powder component has particles of a size less than 25μm.

aa ~~33~~ 29. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to~~ aa ~~32~~, wherein the epoxy resin consists essentially of an epoxy resin which is liquid at ambient temperature.

aa ~~34~~ 30. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to~~ aa ~~33~~, which contains, in percent by weight, from 5 to 50%

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in total of epoxy resin and polycarboxyl compound and 95 to 50% of the metallic powder component.

aa aa ~~35~~ 31. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to 34~~ wherein metal powder (b) is a copper powder which has been cleaned and coated with a stability enhancing copper deactivator which is a chelation agent for the copper and a high temperature catalyst for the crosslinking of the epoxy resin.

~~36~~ 32. A composition according to claim ~~35~~ 31, wherein the chelation agent is an azole compound.

pub B5 37. A composition according to claim 36, wherein the chelation agent is benzotriazole.

aa aa ~~38~~ 34. A composition according to ~~any one of~~ claim~~s~~ 18 ~~to 37~~, wherein metal powder (b) is copper powder and the composition additionally includes anti-oxidant copper deactivating agent.

pub B6 39. A composition according to claim 38, wherein the anti-oxidant copper deactivating agent is oxalyl bis benzylidene hydrazine.

pub Ae3 40. A method of making an electrically conductive circuit on a dielectric surface comprising patterning a dielectric substrate with the admixture of metallic powder component and polycarboxyl compound as specified in claim 18 with the epoxy resin of claim 18 either being pre-coated on the substrate, or the epoxy resin being incorporated in the patterned composition, and heating the dielectric substrate thus patterned to a temperature above the melting point of the solder metal but below the melting point of metal powder (b)., being a temperature at which the polycarboxyl compound is thermally stable but able to act as a fluxing agent to

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achieve metallic sintering and catalyzed crosslinking of the epoxy resin.

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41. The method of claim 40, wherein the epoxy resin ~~is~~ has been pre-coated on the dielectric surface by patterning and the composition is applied to the epoxy resin pattern by matching patterning.

42. A method as claimed in claim 41, wherein the epoxy resin is pre-coated on the dielectric substrate, a photoimageable layer is applied to the adhesive layer, the photoimageable layer is subjected to a photoimaging and developing process to form a channel pattern in the photoimageable layer corresponding to the circuit, said admixture is introduced into the channel pattern and the dielectric substrate is heated to said temperature to achieve metallic sintering and substantial crosslinking of the epoxy resin.

Sub A4

43. A method as claimed in claim 40, wherein a photoimageable layer is applied to the dielectric substrate and subsequently subjected to a photoimaging and developing process to form a channel pattern, said admixture additionally containing the epoxy resin is introduced into the channel pattern and the dielectric substrate is heated to said temperature to achieve metallic sintering and substantial crosslinking of the epoxy resin.

44. A method as claimed in 43 wherein the epoxy resin is coated into the channel of the dielectric substrate and "B" staged prior to the application of the admixture.

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45. A method as claimed in claim ~~42, 43 or 44,~~ 40 wherein the track is formed with an undercut region in side walls thereof.

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46. A method as claimed in 40 wherein the epoxy resin is applied to the entire dielectric substrate and "B" staged to produce a dry handleable substrate allowing for subsequent patterning of said admixture to said substrate.

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47. A method for the production of an electrically conductive circuit which comprises patterning on a substrate, a composition according to ~~any one of~~ claim~~s~~ 40 ~~1 to 39~~ followed by heating of the composition to a temperature sufficient to melt the solder powder and coalesce the metallic film produced, to produce a metal film upon the dielectric substrate and adhesively adhered thereto by a cured and cross-linked epoxy resin.

48. A method of making a multilayered electrically conductive circuit by first applying and curing an insulating dielectric layer on a single layer electrically conductive circuit produced according to the method claimed in ~~any one of~~ claims 40 to 46 the insulating dielectric layer having vias, and forming a second electrically conductive circuit on the cured dielectric layer by the method claimed in any one of claims 40 to 47 and repeating these steps to form a required plurality of alternating dielectric layers and electrically conductive circuit layers.

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49. A method according to claim 48, wherein said vias are filled with a metal filling resulting from filling them with a composition according to any one of claims 18 to 39 having the epoxy resin contained therein and heating to a temperature sufficient to melt the solder metal, coalesce the metals present, cure the epoxy resin and cause the via filling to adhere to the via walls.

50. A method for the production of a multilayer printed wiring board in which electrically conductive circuits on substrates are laid over each other, which substrates include therein vias interconnecting the circuits, in which method the vias are filled with a aa composition according to ~~any one of~~ claim~~s~~ 18 ~~to 39~~ having the epoxy resin contained therein and the resulting assembly is heated to a temperature sufficient to melt the solder powder, coalesce the metallic film, cure the epoxy resin and cause the via filling to adhere to the via walls.

51. A method for the provision of a thermal transfer pillar in a semi-conductor package and/or a multichip module, which comprises depositing a composition as aa claimed in ~~any one of~~ claim~~s~~ 18 ~~to 39~~ having the epoxy resin incorporated as a polymer thick film at a location on said package and/or module at a location at which thermal transfer is required and heating the composition in-situ to a temperature sufficient to melt the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the epoxy resin.

52. A method for the provision of an electrically conductive termination on a printed potentiometer track, which comprises applying a composition as aa claimed in ~~any one of~~ claim~~s~~ 18 ~~to 39~~ having epoxy resin incorporated therein to the potentiometer track as a polymer thick film and heating the composition in-situ to a temperature above the melting point of the solder powder but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the

epoxy resin.

53. A method of joining leads on a printed circuit board, or other substrate, usually for the purpose of repair or modification, which comprises applying a aa composition as claimed in ~~any one of~~ claim~~s~~ 18 ~~to 39~~ having the epoxy resin incorporated therein to a substrate at a predetermined location as a polymer thick film to and heating the composition in situ to a temperature above the melting point of the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial complete crosslinking of the epoxy resin.

54. A method for the production of a shield layer on a multilayer printed wiring board for suppressing of electromagnetic interference or radio-frequency interference, which comprises depositing a composition aa as claimed in ~~any one of~~ claim~~s~~ 18 ~~to 39~~ having epoxy resin incorporated therein on a said wiring board and heating the composition in-situ to a temperature above the melting point of the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the epoxy resin.

55. A method of joining electronic components to aa substrates whereby the composition as claimed in ~~any~~ aa ~~one of~~ claim~~s~~ 1 ~~to 39~~ is used as an electrically conductive adhesive to adhere the electric components to a said substrate.

56. A method as described in Claim 56, where the substrate has been produced by a method as claimed in aa ~~any of~~ claims 40 ~~to 46, 48 and 49~~ and the electronic components are placed into the said composition prior

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to the temperature being raised, the substrate is then heated to said temperature thus forming the electrically conducting circuit and joining the electronic components simultaneously to an electrically conductive circuit.

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